Collection System Certification Practice Math Problems With Answers

Class I

1. A new manhole is going in and you have to remove a circle of asphalt 35 feet in diameter. How many square feet of material must be removed?

$$35\ ft^2 \times 0.785 = 961.62\ ft^2$$

2. If the asphalt in the problem above is 8 inches thick, how many cubic feet of material must be removed?

$$8 \text{ inches} \div 12 \text{ inches} = 0.66 \text{ ft}$$

$$35\ ft^2 \times 0.785 \times 0.66\ ft^2$$
$$=$$
$$634.67\ ft^3$$

3. A rectangular wet well is 12 feet x 24 feet, what is the surface area in ft^2 of this wet well?

$$12 \text{ ft} \times 24 \text{ ft} = 288\ ft^2$$

4. If the wet well in the above mentioned problem is 16 feet deep, what is the volume of the wet well in ft^3?

$$12 \text{ ft} \times 24 \text{ ft} \times 16 \text{ ft} = 4{,}608\ ft^3$$

5. If the wet well in the above mentioned problem is 16 feet deep, what is the volume of the wet well in gallons?

$$4{,}608\ ft^3 \times 7.48 \text{ gal per } ft^3$$
$$=$$
$$34{,}468 \text{ gallons}$$

6. You are adding 16.5 pounds of chlorine per day at 12 PPM for odor control to a 45 feet deep, 25 feet in diameter lift station with an influent flow of 256.5 gpm and an effluent pump rate of 287.9 gpm. How many pounds of chlorine will be added to this station daily?

$$16.5 \text{ lbs}$$

7. Manhole # 22 is 475 feet from manhole # 23. On the blueprints, 1 inch = 100 feet. How long is the line on the blueprint?

1 inch per 100 ft X 475 ft
=
4.75 inches

8. The line on the blueprints is 7.5 inches long between manhole #33 and #34. Each inch is equal to 50 feet. How many feet are there between manholes #33 and #34?

7.5 inches X 50 ft per inch
=
375 ft

9. How many gallons per day would a community of 17,425 people contribute to the collection system daily?

Population X 100 gal/person/day
=
17,425 X 100 gal
=
1,742,500 gal/day

10. A sewer has failed and 61 feet of 12-inch pipe must be replaced. How many 10 foot sections will be required?

$$\frac{61 \text{ ft}}{10 \text{ ft}}$$
=
7 10 ft sections

Class II

11. What is the capacity of a wet well if the pump, rated at 125 gpm, requires 1 hour 4 minutes to empty? Assume no inflow.

1 hr 4 min
=
64 min

64 min X 125 gpm
=
8,000 gal

12. What is the percent grade on a 2 foot rise in 300 feet?

$$\frac{\text{Rise in ft}}{\text{Run in ft}} = \frac{2 \text{ ft}}{300 \text{ ft}} = .0066\%$$

13. To lay a new line you must dig a trench 5 feet deep, 3 feet wide and 475 feet long (assume vertical sidewalls). How many cubic feet of material must be excavated to complete this project?

$$5 \text{ ft} \times 3 \text{ ft} \times 475 \text{ ft} = 7{,}125 \text{ ft}^3$$

14. Using the data from the pervious problem, if you had an 8 cubic yard dump truck, how may loads would have to be moved to stockpile the excavated material?

$$\frac{7{,}125 \text{ ft}^3}{27 \text{ ft}^3 \text{ per YD}^3 \times 8 \text{ YD}^3 \text{ per truckload}} = \frac{7{,}125 \text{ ft}^3}{216 \text{ ft}^3 \text{ per load}} = 33 \text{ loads}$$

15. An 18 feet deep lift station has a diameter of 12 feet; the influent flow causes the water level to rise 4.5 feet in 22 minutes. What is the influent flow rate in gpm?

$$12 \text{ ft}^2 \times 0.785 \times 4.5 \text{ ft} = 508.68 \text{ ft}^3$$

$$508.68 \text{ ft}^3 \times 7.48 \text{ gal per ft}^3 = 3{,}804.92 \text{ gal}$$

$$\frac{3{,}804.92 \text{ gal}}{22 \text{ min.}} = 172.95 \text{ gpm}$$

16. A junction box is 12 feet wide and 18 feet long and the bottom slopes from 12 feet deep on one end to 15 feet deep on the other. What is the volume in gallons of the junction box?

$$12 \text{ ft} \times 18 \text{ ft} \times \frac{(12 \text{ ft} + 15 \text{ ft})}{2}$$

$$=$$

$$2{,}916 \text{ ft}^3$$

$$\text{Gallons}$$

$$=$$

$$2{,}916 \text{ ft}^3 \times 7.48 \text{ gal per ft}^3$$

$$=$$

$$21{,}811.7 \text{ gal}$$

17. A 25 feet deep lift station has a diameter of 20 feet; the influent flow causes the water level to rise 2 feet 9 inches in 42 minutes. What is the influent flow rate in gpm?

2 ft 9 inches

Divide 9 inches by 12 inches to get a decimal %

$$\frac{9 \text{ inches}}{12 \text{ inches}}$$

$$=$$

$$0.75 \text{ ft}$$

$$20 \text{ ft} \times 20 \text{ ft} \times 0.785 \times 2.75 \text{ ft}$$

$$=$$

$$863.5 \text{ ft}^3$$

$$\text{GPM}$$

$$=$$

$$863.5 \text{ ft}^3 \times 7.48 \text{ gal per ft}^3$$

$$=$$

$$\frac{6{,}459 \text{ gal}}{42 \text{ min}}$$

$$=$$

$$153.8 \text{ GPM}$$

18. The elevation at the upper manhole is 436.7 feet, the elevation at the manhole 275 feet downstream is 430.4 feet. What is the slope?

$$\text{Slope} = \frac{436.7 \text{ ft} - 430.4 \text{ ft}}{275 \text{ ft}}$$
$$= \frac{6.3 \text{ ft}}{275 \text{ ft}}$$
$$= 0.023^{0}$$

19. From manhole #345 to manhole #346 is 395 feet of 14 inch pipe. The grade off the plans is 4% or 0.04. How much drop in feet of elevation will there be from #345 to #346?

$$\text{Difference in elevation} = \text{\% Grade X run of pipe in ft}$$
$$= .04 \text{ X } 395 \text{ ft}$$
$$= 15.8 \text{ ft}$$

20. The distance between manhole #645 and #646 is 455 feet of 8 inch PVC pipe. A dye packet was added to manhole #645 and 4 minutes 45 second later color was observed in manhole #646. What is the velocity of the wastewater?

$$\text{Velocity} = \frac{\text{Distance in ft}}{\text{Time in sec}}$$
$$= \frac{455 \text{ ft}}{4 \text{ min. X } 60 \text{ sec per min} + 45 \text{ sec} = 285 \text{ sec}}$$
$$= \frac{455 \text{ ft}}{285 \text{ sec}}$$
$$= 1.6 \text{ ft per sec}$$

21. A 12 inch wide channel is running 8 inches deep at a rate of 3 feet per second. What is the flow rate in gallons per minute?

Flow = area X velocity

Area = Ft^2

12 inches X 8 inches = 1 ft X 0.66 ft
(8 inches ÷ 12 inches = 0.66 ft)
=
0.66 ft^2

0.66 ft^2 X 3 ft/sec
=
1.98 ft^3/sec

1.98 ft^3/sec X 7.48 gal/ft^3
=
14.81 gal/sec X 60 sec/min
=
888.62 gpm

22. A flow of 980 gpm is flowing through a 15-inch wide channel at a depth of 9 inches. What is the flow rate in feet per second?

Velocity = flow ft^3 ÷ area in ft^2

15 in. X 9 in. = 1.25 ft X 0.75 ft
(15 in ÷ 12 in =1.25, 9 in ÷12 in = 0.75 in)
=
0.937 ft^2

Flow in ft^3
=
980 ÷7.48 gal/ft^3

131 ft^3 min ÷ 60 sec/min
=
2.18 ft^3/sec

Velocity
=
2.18 ft^3/sec ÷ 0.937 ft^2
=
2.33 ft/sec

23. The meter reading on lift station #76 on April 10 at 8:00 AM was 32,445,560 gallons. On April 17, at 8:00 AM the meter reading was 41,896,760 gallons. What is average daily flow through this lift station?

41,896,760 gals
-32,445,560 gals
9,451,200 gals

Average = total gals ÷ # of days

9,451,200 ÷ 7 days
=
1,350,000 gals/day

24. Using the data from the previous problem, if you were feeding 9 mg/l of chlorine for odor control how many pounds of chlorine would be fed per day?

Lbs = flow/MGD X 8.34 X concentration mg/l
=
1.35 MGD X 8.34 X 9 mg/l
=
101.33 lbs/day

25. Using the data from the previous problem, if chlorine sells for 1.17 per pound, what is the monthly chemical bill for chlorine?

101.33 lbs/ CL_2/day X $1.17 per lbs CL_2
=
$118.55/day X 30 days
=
$3,556.68/monthly CL_2 Cost

26. Average flow to a wastewater treatment plant is 0.9 MGD. On a wet weather flow day the flow rises to 3.3 MGD. What is the percentage of inflow and infiltration?

$$\frac{\text{Current flow}}{\text{Average flow}} \times 100$$
=
$$\frac{3.3 \text{ MGD}}{0.9 \text{ MGD}} \times 100$$
=
366.6%

27. The elevation of manhole #34 is 342.6 feet and the elevation of manhole #33 is 335.6 feet and they are 370 feet apart. What is the percent of slope?

$$\frac{342.6 \text{ ft} - 335.6 \text{ ft}}{370 \text{ ft}}$$
$$=$$
$$\frac{7 \text{ ft}}{370 \text{ ft}}$$
$$=$$
$$0.018^{0} \text{ slope}$$

28. The wet well of a pump station is 6 feet wide by 6 feet long. With one pump running and discharging 280 gpm, the wet well level was observed to rise 2 feet in 3 minutes 15 seconds. What was the rate of flow into the wet well?

$$6 \text{ FT} \times 6 \text{ Ft} \times 1 \text{ FT}$$
$$=$$
$$36 \text{ ft}^3$$

$$36 \text{ FT}^3 \times 7.48 \text{ gal/FT}$$
$$=$$
$$269.3 \text{ gal} \div 3.25 \text{ min}$$
$$=$$
$$82.85 \text{ gpm} + 280 \text{ gpm pump rate}$$
$$=$$
$$362.85 \text{ gpm}$$

29. The average flow to your facility is 0.85 MGD. When you receive a 1-inch rain your flow increases to 3.1 MGD. What is the percentage of inflow and infiltration?

$$\frac{\text{Actual flow}}{\text{Daily average flow}} \times 100$$
$$=$$
$$\% \text{ increase}$$

$$\frac{3.1 \text{ mgd}}{0.85 \text{ mgd}} \times 100$$
$$=$$
$$364\%$$

30. A new manhole has been installed 350 feet from an existing manhole. On a map with a scale of 1 inch equals 75 feet, how far would this new manhole be located from the existing manhole?

$$\frac{350 \text{ ft}}{75 \text{ ft}}$$
$$=$$
4.66 inches

Class III

31. The invert elevation of a manhole is 422.3 feet. If the invert at the next down stream manhole is 300 feet away at a 0.033 slope, what will the invert elevation be?

Fall in ft = distance X slope
$$=$$
300 X 0.033 = 9.9 ft

422.3 ft – 9.9 ft
$$=$$
412.4 ft

32. The elevation at the invert of manhole #567 is 737.8 feet. The next manhole #568 is 410 feet downstream with an invert elevation of 729.4. What is the percent grade of this run of pipe?

$$\text{Grade} = \frac{\text{difference in elevation}}{\text{Run is feet}}$$

737.8 ft - 729.4 ft
$$=$$
$$\frac{8.4 \text{ ft}}{410 \text{ ft}}$$
$$=$$
.02% or 2 percent

33. A 14 inch forcemain 4,500 feet long has a flow rate of 0.77 MGD. What is the detention time in the forcemain?

Detention time = Volume / gal ÷ Flow / gpm

Volume/gal
=
14 inches = ? ft
=
$\frac{14 \text{ inches}}{12 \text{ inches}}$
=
1.16 ft

1.16 X 1.16 X 0.785 X 4,500 ft X 7.48 gal / ft^3
=
35,555 gal

Flow in GPM
=
0.77 MGD ÷1,440 min/day
=
534.72 gpm

$\frac{35{,}555 \text{ gal}}{534.72 \text{ gpm}}$
=
66.49 min
=
1.1 hr

34. Two 12.5 HP pump run for 7.75 hours per day each, one is 85% efficient, the other is 75 % efficient How many kilowatt hours were used in a 24 hour day?

$$\frac{\text{HP X 0.746 kw per HP X time in hrs}}{\text{efficiency}}$$

=

$$\frac{\text{12.5 X 0.746 kw/hp X 7.75 hr}}{85\%}$$

=

72.26 kwhr

$$\frac{\text{12.5 X 0.746 kw/hp X 7.75 hr}}{75\%}$$

=

54.20 kwhr

Total KWHR

=

72.26 kwhr + 54.20

=

126.46 kwhr/day

35. Using the data from the previous problem, at $.14 per kwhr what is the 30 day electrical cost to operate this lift station?

126.46 kwhr/day X 30 days X $.14 /kwhr

=

$531.13

36. On a wet weather day the flow into a 35 foot diameter lift station has just activated the lag pump, and only one pump appears to be in operation and the water level is rising at a rate of 1 foot every 2 minutes 45 seconds. If the elevation of the lag pump switch is 452.8 feet and the manhole will overflow to the street at an elevation of 466.7 feet, how long do you have to repair or replace the defective pump?

Difference in elevation X mins per foot = mins to overflow

=

466.7 – 452.8 X 2.75 ft/min rise

=

38.2 min or 38 mins, 12 sec

37. A lift station with two 12.5 HP submersible pumps operates on an alternating cycle with pump #1 running 6.7 hours and pump #2 running 6.9 hours. These pumps have an efficiency average of 87.2%. At $.11 per kilowatt hour, what will it cost to operate the lift stations for 30 day month?

$$\text{Kilowatts hours} = \frac{12.5 \times 0.746 \times 6.7 \text{ hr run time} + 6.9 \text{ hr run time}}{87.2\% \text{ efficiency}} = 128.82 \text{ kwhr}$$

$$\text{Cost @ \$.11 per kwhr} = \$.11 \times 128.82 = \$13.95/\text{day} \times 30 \text{ day mo.} = \$418.50$$

38. A lift station wet well is 14 feet in diameter and 22 feet deep. At a depth of 8 feet 4 inches, how many gallons of wastewater are in this wet well?

$$14 \text{ ft} \times 14 \text{ ft} \times 0.785 \times 8.33 \text{ ft} = 1281.65 \text{ ft}^3$$

$$1281.65 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 9586.77 \text{ gal}$$

39. What concentration of chlorine in mg/l, is applied to a flow of 3.5 MGD if the total weight of 100% available chlorine used was 350 pounds?

$$\text{Mg/l} = \text{Lbs} \div \text{flow/MGD} \times 8.34 = \frac{350 \text{ lbs}}{3.5 \text{ MGD} \times 8.34} = \frac{350 \text{ lbs}}{29.19} = 11.99 \text{ mg/l}$$

40. A sewer line is to be filled with a root control solution containing 75 mg/l of a specific chemical. How much chemical in pounds, would be needed for a 265 feet long section of 12-inch line?

Flow
=
gallons in pipe
=
1 ft X 1 ft X 0.785 X 265 ft
=
208 ft^3 X7.48 gal/ft^3
=
1556 gal

Convert to MGD
=
0.001556 MGD X 8.34 X 75 mg/l
=
0.97 lbs

Class IV

41. A 40 HP pump runs for 18 hrs per day and is 85% efficient. How many kilowatt hours were used in a 24 hour day?

$$\frac{\text{HP X 0.746 kw per HP X time in hrs}}{\text{efficiency}}$$
=
$$\frac{\text{40 X 0.746 kw/hp X 18 hr}}{85\%}$$
=
456.55 kwhr

42. Using the data from the problem above and one kilowatt hour cost $.13; what would the total electric cost be to operate this lift station for 1 year?

456.55 kwhr X $.13 = $59.35/day

$59.35/day X 365 days/year
=
$21,662.75

43. A 24-inch force main is to be laid 3,675 feet from lift station #12 to the wastewater plant at an in-place cost of $202.00 per foot. What is the total cost of this project?

# of ft X cost per ft in-place
=
3,675 X $202.00
=
$742,350.00

44. If the labor cost was 13.5% of the total cost, what is the labor cost?

13.5% X $742,350.00
=
$100,217.25

45. What would the excavation cost be if it was 61.2% of the total?

61.2% X $742,350.00
=
$454,318.20

46. If materials cost is all that is left, what percentage of the total project cost is it?

13.5% + 61.2%
=
74.7%

100% - 74.7%
=
25.3%

47. You want to check the flow rate of a pump in a lift station rated at 250 gpm to determine its efficiency as compared to its rated capacity. The lift station has a diameter of 10 feet and a depth of 25 feet. The influent flow to the lift station rises, with no pump running, at a rate of 8 feet in 10 minutes and with the pump running the rise rate is 5 feet in 10 minutes

a. What is the influent rate in gpm?
b. What is the rise rate with a pump running in gpm?
c. What is the pump rate in gpm?
d. How efficient is this pump in %?

Influent rate:

$$\frac{0.785 \text{ X (Diameter)}^2 \text{ X depth X } 7.48 \text{ gal/ft}^3}{\text{Min}} = \text{GPM}$$

$$0.785 \text{ X } (10)^2 \text{ X } 8 \text{ ft X } 7.48 \text{ gal/ft}^3 = 4697.4 \text{ gal}$$

$$\frac{4697.4 \text{ gal}}{10 \text{ Min}}$$

a.

=

469.7 GPM

Rise rate:

$$\frac{0.785 \text{ X (Diameter)}^2 \text{ X depth X } 7.48 \text{ gal/ft}^3}{\text{Min}} = \text{GPM}$$

=

$$0.785 \text{ X } (10)^2 \text{ X } 5 \text{ ft X } 7.48 \text{ gal/ft}^3 = 2935.8 \text{ gal}$$

=

$$\frac{2935.8 \text{ gal}}{10 \text{ min}}$$

b.

=

293.5 GPM

Pump rate:

=

Influent – Rise Rate

=

GPM

=

469.7 GPM – 293.5 GPM

(continued on next page)

c.

=

176.2 GPM

Percent efficient:

=

Pump rate /GPM

Pump rating/GPM

=

176.2 GPM

250.0 GPM

d.

=

70.4 %

48. A town has two main lift stations, 25 feet in diameter and 40 feet deep. Pump station #1 has a total of three 1,000 gpm pumps, two that alternate with the third as a back up. The two alternating pumps work at 91% efficiency. In pump station #2 there is the same set up except the pumps are 1,250 gpm that operate at 89.5% efficiency. Both of these stations feed the main in-plant station with the total flow to the treatment plant.

a. If station #1 operated for a total of 18.4 hr how many GPD are pumped to the inplant station?
b. If station #2 operated for 21.6 hr how many GPD will it pump to the in plant station?
c. What is the total flow to this plant in MGD?

Flow in GPD

Pump flow rate X pump efficiency X min of operation

Min of operation

Hours of operation X 60 min/hr

(**A**)18.4 hrs X 60 min/hr

1,104 min

1000 gpm X 91% X 1104 min

1,004,640 GPD

(continued on next page)

(**B**) 21.6 hr operation X 60 min/hr

1296 min

1250 gpm X 89.5% X 1296 min

1,449,900 GPD

(**C**) Total flow in MGD

(**A**) + (**B**) = (**C**)

1,004,640 + 1,449,900 = 2,454,540

Convert to MGD move decimal 6 places to the left

2.45454 MGD

49. Using the data provided, what is the daily average flow rate from this lift station?

Flow meter readings:

Monday	March 20, 2009	223,234,445 gallons
Monday	March 27, 2009	243.879,629 gallons

243,879,629 gal - 223,234,445 gal
=
20,645,185 gal

Average daily flow
=
$\frac{20,645,185 \text{ gal}}{7 \text{ days}}$
=
2,949,312 gpd